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Structure and Evolution of Dune Massifs in the Vilyui River Basin over the Late Quaternary Period (by the Example of the Makhatta and Kysyl-Syr Tukulans)

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Abstract—The data of the comprehensive study of deposits of dune sand massifs—the Makhatta and Kysyl-Syr Tukulans—in the Vilyui River Basin (Central Yakutia) are given. We have revealed the structure and preliminarily reconstructed the evolution of tukulans in the Vilyui River basin and the environmental conditions of the surrounding area in the Late Pleistocene–Holocene period (the chronological period of the formation of tukulans) on the basis of lithological and palynological data and 17 radiocarbon datings. It has been revealed that the tukulans should be assigned to eolian deposits formed on sediments of complicated facial structure. We have distinguished four stages in the vegetation evolution within the last 40000-year period and three chronostratigraphical phases in the development of dune massifs.

Keywords: tukulan, lithology, radiocarbon dating, age model, palynology, Pleistocene, Holocene, Central Yakutia

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INTRODUCTION

The Vilyui River basin is one of the regions where unique relict and modern massifs of dune sands of Yakutia are spread. Here, they are called tukulans. The area occupied by them in the investigated region is significant: about 60000 km^2. The largest ancient sand massifs are located in the valley in the lower and middle reaches of the Vilyui River.

From the geomorphologic point of view, tukulans are dunes of the higher order. Three levels of features of topography are easily seen in their structure: mesofeatures (dune chains), microfeatures (dunes, deflation basins, deflation corridors, and depressions between hummock), and nanofeatures (mounds, grass clusters, microlevees, "clay mushrooms", and ripples) (Pavlova et al., 2015).

Various aspects of the origin of dune massifs in Yakutia have been discussed by geographers, botanists, geomorphologists, specialists in geocryology, and geologists since the 19th century: Maak (1886); Kuznetsov (1927); Grigor'ev (1932); Rabotnyi (1935); Nevyazheskii and Bidzhiev (1960); Katasonova and Tolstov (1963); Alekseev and Giterman (1973); Pavlov et al. (1981); Kolpakov (1983); Lukin and Tolstikhin (2005, 2008); and many other scientists (Grigor'ev and Pavlov, 1977; Pavlova et al., 2016).

Nevertheless, paleogeographical aspects of the development of tukulans (their age, formation history, and specific features of changes with space and in time of their vegetation and climate and in the region in general) are insufficiently investigated or are not discussed at all in the published issues. This makes it difficult to study climate dynamic in Yakutia in the Quaternary Period and the related changes in the cryolithozone, paleolandscapes, and paleobiota.

The aim of this work is to reconstruct the structure and evolution of tukulans in the Vilyui River Basin and the environmental conditions of the surrounding area in the Late Quaternary Period on the basis of data from lithological, palynological, and radiocarbon analyses of deposits of dune massifs: the Makhatta and Kysyl-Syr tukulans.

The studied tukulans are typical cryogenic–eolian formations of Yakutia. The pits lain on dune massifs and complementing one another show the history of these objects and of the area in general over the investigated period.